This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Homer
1832

600010285M

32.

542.

NATURAL MAGIC.

A

FAMILIAR EXPOSITION

OF A

FORGOTTEN FACT

IN

OPTICS.

INCLUDING STRICTURES ON A. GELLIUS AND HIS INTERPRETERS.

By W. G. HORNER.

BATH:

PRINTED BY GEORGE WOOD, PARSONAGE LANE;
AND SOLD BY LONGMAN AND CO., PATERNOSTER ROW, LONDON;
COLLINGS, BATH; AND KING AND SONS,
OPTICIANS, BRISTOL.

1832.

542.

BIBLIOTHECA BODLEIANA

PREFACE.

THE object of this Tract is twofold; to inform the reader of a fact not to be learned elsewhere, and to shew that that fact was not unobserved by the ancients. Of course, I am more solicitous about the former position than the latter, and trust that, if any person is of opinion that I have not revived a *forgotten* fact, he may allow it to pass to my account as an *original* one.

Some pains have been taken to ascertain that the principle is new to modern times; and I gratefully acknowledge the readiness with which my friends have promoted my endeavours in this way, by supplying me with books

not contained in my own little collection. To Sir George S. Gibbes I am particularly indebted, through whose kindness I have consulted the Natürlichen Magie of Wiegleb, a compilation in 18 octavo volumes, continued with German industry during 15 years. In this mass of curious research, no allusion is found to my principle, but rather proof of its latency.

The immediate value of the fact itself is no object of regard. It is sufficient if it prove entertaining. Facts in science find their value, in finding their place among kindred facts.

Classical Seminary, Grosvenor Place, Bath;
October, 1832.

FAMILIAR EXPOSITION, &c.

In Sir David Brewster's entertaining volume of Letters on Natural Magic, recently published in the Family Library, the following passage occurs (p. 58): "There is one property mentioned by Aulus Gellius, which has given unnecessary perplexity to commentators. He states that there were specula, which, when put in a particular place, gave no images of objects, but when carried to another place, recovered their property of reflection." Salverte's explanation, that the property in question may be analogous to the phenomena of polarized light, being rejected as too "profound," Sir David offers one of his own, in these words: "We may easily understand how a silver mirror may instantly lose its reflecting power, in a damp atmosphere, in consequence of the precipitation of moisture upon its surface, and may immediately recover it when transported into drier air."

Beloe's translation, following the Delphin comment rather than the simple text, gives

quite a different turn to the passage. "A glass, placed in a certain position, shews nothing; turn it, and it shews many images."

That the merits of these various opinions may be more apparent, I shall extract the original, at sufficient length to give the author the complete benefit of his own testimony. Gellius's words are these:

"Pars quædam Geometriæ, ὀπτικὴ appellatur, quæ ad oculos pertinet: pars altera, quæ ad aures, κανονικὴ vocatur qua musici, ut fundamento artis suæ utuntur. Utraque harum, spatiis et intervallis linearum et ratione numerorum constat. Οπτικὴ facit multa demiranda id genus; (1) ut in speculo uno imagines unius rei plures appareant; (2) item, *ut speculum, in loco certo positum, nihil imaginet, aliorsum translatum, faciat imagines;* (3) item, si rectus speculum spectes, imago fiat tua hujusmodi, ut caput deorsum videatur, pedes sursum."—*Noctes Att. lib.* 16, *cap.* 18.

Each of these three "items" has called forth almost as many rival interpretations as any enigma in the Ladies' Diary, and which it would be as little to our purpose to detail. With the Delphin editor, I regard the *first* as an allusion to the repetition of images reflected in a plain mirror when placed opposite to another. Seneca* describes the effect. So does Lucretius;† and the subject is introduced in

* Nat. Quest. i. 13. † Lib. iv. 303, &c.

this place, for the sake of drawing the reader's attention to the mathematical accuracy of the poet's enumeration of the images, by which he furnishes a standard for comparing the luminous power of the common metallic mirrors of his day with that of the modern silvered looking-glasses.

Quinque, etiam sex, ut fieri simulacra suerint.

"Five, or even six," is still, I fancy, much nearer to the number of copies which a person can discover, of his own features, in trying this experiment, than the Delphin annotator's estimate of "centies et amplius." With all the economy of light adopted in the kaleidoscope, a decagonal figure, composed of five pairs of direct and as many of reverted images, is barely tolerable; and beyond that extent, the light diminishes rapidly.

In the *third* clause, few readers, I suppose, will doubt but that Gellius describes the inverted image which a person sees of himself, when he stands in front of a concave mirror, and at a certain distance from it; that is, not nearer to it than the length of its radius of concavity. If so, the manner in which this is stated may perhaps render more intelligible

the clause in italics, which has been the subject of such diversity of opinion. It is not an unreasonable supposition, as our author affects some precision in his choice of words, that the same effect was intended by the words "faciat imagines" and "imago fiat," an effect distinct from that conveyed by "in speculo imagines appareant." He very probably designed to make a neat distinction between images really formed in the air, and those which are only apparently existing behind the mirror. And I am the more inclined to infer this, from his avoiding altogether the word *reddo*, which is usually employed to denote simple reflection, and adopting the rare but expressive word *imagino*; the passive form of which is used by Lactantius in this very sense, of modelling a real figure; as is the cognate verb *effigio** by writers of that age. The expression "*imaginata pictura*," cited by Calepin from Gregory of Tours, would appear to strengthen the conjecture.

* Calepin regards these two words as equivalent. They are so rarely used, and only by inferior writers, that it is difficult to discover the truth respecting them. The distinction between *imago* and *effigies* I have not seen correctly stated. If we appeal to Virgil and Cicero, *effigies* should mean an accurate resemblance, perfect in all its lineaments; and *imago* a finished resemblance, complete in all its accompaniments.—See Note A, p. 21.

But, not to attribute to verbal criticism more than its due weight as a secondary testimony, it is clear from the entire passage that both Salverte and Brewster must be in error, because neither of their solutions is reducible to the *geometrical* principles of optics recognised by the ancients. A cloth screen or a brick wall is as good a geometrical "locus" as a damp atmosphere, and rather more effectual for extinguishing the power of reflection. The commentator surely made a nearer approach to the truth, who referred to the principles, that "any object which is in the *centre* of the concave mirror cannot be seen," and that "if the eye is in the centre, it can see nothing but itself." And if Gellius spoke of the reflection which a person sees of his own form in a mirror, he probably had this situation in his view. Let the mirror be placed at a distance from the spectator equal to its radius of concavity, and he could see no image of himself; but on placing it either nearer or farther off, he would see, in the former case an erect, and in the latter an inverted image.

With this explanation it is probable that most of Gellius's readers have been satisfied.

For my own part, I think Sir David and M. Salverte have done well in mooting the inquiry afresh. If this be the intended purport of the passage, it appears to me to be vaguely, not to say fantastically expressed. Why, for instance, "*nihil imaginet*," if those words mean "will reflect nothing," when every object between the spectator and the mirror would be distinctly reflected? It is easy to say, with the French writer, that the author "was not sufficiently acquainted with the subject;" but it is treating both him and one's self unjustly, to be satisfied with such a *pis aller*, when possibly the author might with more truth retort a charge of inadvertence on his critic.

To prove that Gellius is treating of the images which appear actually suspended in the air before a concave mirror, I propose to illustrate his meaning by a few amusing experiments, which will show that the extinction of such images may be attended with as magical effect as their appearance. Depending upon the property of a focal point, which, to the best of my knowledge, has not received distinct consideration from writers on optics, my experiments may furnish future lecturers with a pleasing variation of exhibition. The

point to which I allude is the *visual focus*, or the aerial image of the observer's eye. This image being produced by the re-union of all the rays which, diverging from the pupil, had impinged upon the whole surface of the mirror, and been thence reflected according to the well-known law, it follows, that every line of incidence which can be drawn from the pupil to the mirror, has its corresponding line of reflection passing through the image of the pupil. Re-trace these lines, and it is equally evident that every line of reflection which arrives at the pupil, must proceed from a line of incidence which had passed through the image of the pupil, or would do so, if prolonged backwards.

The consequence is, that the situation of every object, whose image is visible by means of the mirror, has a relation to the image of the eye, similar to that which the situation of the image of the object has to the eye itself. The images are confined within the two conical spaces whose common apex is at the eye, and whose periphery is limited to that of the mirror: the objects will be found within two conical spaces similarly limited, but whose apex is the image of the eye.

There is however a remarkable diversity in the distribution of the objects and their representatives, in these four spaces; and it will be found, that the originals of those aerial images which appear between the observer and the mirror, are situated in that space which is *beyond* the visual focus. For, let e, ε, be the distances of the eye and its image from the centre of the mirror's surface; and o, ω, those of any object and its image from the same centre. In situations not very remote from the axis, these distances are connected by the equation

$$\frac{1}{e} + \frac{1}{\varepsilon} = \frac{1}{o} \pm \frac{1}{\omega}$$

the negative sign indicating an apparent image formed behind the mirror. This equation, transposed, becomes

$$\frac{1}{\varepsilon} - \frac{1}{o} = \pm \frac{1}{\omega} - \frac{1}{e}$$

the first member of which is positive, only when o is greater than ε; and the latter, only when ω is positive and less than e: which conditions are consequently inseparable.

Since, therefore, the objects which give the aerial images affect the observer's eye only by means of rays actually *incident through the image of the pupil*, it is manifest that if the place of that image is occupied by any opaque

substance, no aerial images whatever can be seen by such observer. This is the fact to be illustrated.

Experiment I. Placing yourself in front of a large concave mirror, at the distance of a few inches beyond its centre of curvature, observe the inverted image of yourself, which appears between you and the mirror. Familiarize yourself with the exact situation of the head of the image, by touching it in different parts, looking alternately at the part you attempt to touch, and at the finger with which you approach it, until you are satisfied that both are seen distinctly, with the same adjustment of the eye. When you can place your finger with certainty upon any point of the image at pleasure, extend the fore-finger of each hand, and placing them against the temples of the image, bring them gradually and simultaneously into contact with its eyes. At the instant *when they occupy the place of the pupils of the eyes, every aerial image will vanish,* and the surface of the mirror will appear suffused with the carnation hue of the finger.

Or, after carefully ascertaining the place of the image as before, close one eye, and place

a finger on the pupil of the other's image, and the same effect will follow.

Experiment II. Place another person in front of the mirror, at any convenient distance beyond the centre, and cause him to cover one eye, and to observe with the other the images which appear in the air. (This may be so arranged that he shall not see his own image.) Now advance your finger to the image of his head, and having well ascertained its exact place, touch the pupil of the eye. The person will observe the same effects, which occurred to you in the former experiment.

Experiment III. (A magical surprise.) Let the flame of a candle be held at some point in the space from which the company are to view the images exhibited in front of a mirror; and mark accurately the spot where the image of the candle is formed. In the place of the flame fix a flat ring with a broad margin, and in the place of the image a small circle of black velvet. The same screen S, which conceals from the observer the objects O, whose images are to be shewn, may conceal the stop P, without at all obstructing his view of the mirror.*

* See the Diagram, p. 19.

The aerial images, visible to every one besides, will not appear to the person who looks through the ring. The place of the mirror will appear a dark vacuity; which will be the more surprising, because no opaque object is interposed to intercept the view. The opening of the ring may be elongated, so as to permit the use of both eyes, provided the velvet patch is proportionally extended.*

Experiment IV. Close the opening of the partition, except the space occupied by the ring; the spectator will perceive no images. Remove the mirror a very little way in any direction, and the images will appear as usual.

The result of the last experiment accords so minutely with the description in the Noctes, that it ought not without cogent reasons to be denied to represent the author's meaning. It is certain, besides, that effects similar to these must have occurred to the observation of persons who had frequent access to a convex mirror; and that they would attract more attention among a people who applied such apparatus solely to the purposes of curiosity and delusion, than they do with us. We

* See Note C, p. 23.

cannot believe that means so ready as these experiments disclose, of causing an apparition to disappear instantaneously, or to be invisible to any particular individual while it remained visible to others, were overlooked by the hierophants and thaumaturgists of old times. In confirmation also of these conjectures, it ought not to be overlooked, that experiments of this description can be much more neatly and boldly executed with metallic specula than with mirrors of silvered glass. In the latter, the double surface gives a double focus to be stopped; while in the former, even when the focus is becoming a caustic, the least transverse section of this will be a sufficient measure of the obstacle to be employed, and when that is away, the images of objects near the screen may be sufficiently correct.

The difficulty which occurs, from our knowledge, or rather ignorance, of the progress made by the ancients in optical geometry, is not altogether insurmountable. It is not certain, that in giving these three specimens of the wonders which optics "performed" *(facit,)* Gellius meant to affirm that it had succeeded in *explaining* them all. It is highly probable that they were explained in some treatise extant

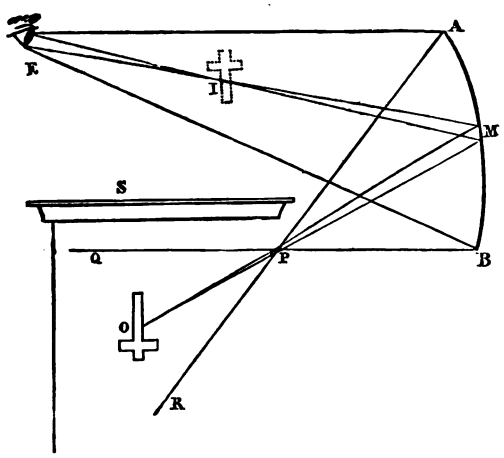
in his time, but which has not come down to us. The Catoptrics (ycleped) of Euclid, but probably much posterior in date to Gellius, cannot be admitted as definitive witness on the point; a compilation of tyro reminiscences and blunders, so unfortunate, that, out of three propositions which the Oxford editor, Dr. D. Gregory, has marked as in better "taste" than the rest—*veram sapiunt Geometriam*—one (the 23d*) is true but not demonstrated, and another (the 28th), though demonstrated, is not true.—See Note B, p. 22.

Nevertheless, to quit these negative surmises, we may detect even in the "Catoptrics," and more palpably in the "Optics" ascribed to Euclid also, traces of what the real Euclid or one of his genuine followers is likely to have accomplished. The "phænomena" prefixed to the Catoptrics, though erroneous, are sufficient to prove the attention given to the inquiry, "What point about a mirror must be occupied, to prevent objects from being seen in the mirror?" The Optics apparently are the work of an older author and somewhat superior. His "second thesis," of the

* Perhaps there is an error of the press about this number. Probably it was designed for 27th (the 3 and 7 of a century back being written much alike), which is connected with the 28th, and has the same fault.

visual cone of rays, is just the principle which is wanting in the other treatise, for the solution of this inquiry. It is worth notice, too, that he is fond of investigating *loci*, and begins many propositions with, "There is a certain place," the very phrase quoted by Gellius, and which nowhere, I believe, occurs in the Catoptrics. So that, upon the whole, if he had written on this department, he would very probably have had a proposition of this tenor; "There is a place in the line drawn from the eye to a concave mirror through the centre of the sphere, which being occupied, nothing which is farther from the mirror than that place, can be seen;" and as far as the spherical aberrations did not baffle him, he could have proved it.

In fine; the existence of such a property in the apex of the cone of reflected visual rays being known, as it must have been, by experience, the rationale must as certainly have been investigated, and the rudest investigation would have fully entitled it, in a Roman's judgment at least, to be classified among the scientific marvels of optics.



EXPLANATION OF THE DIAGRAM.

A B. The concave mirror.

O. Any object concealed from the observer at E by the screen S.

I. Its aerial image.

P. The image of the pupil of the eye, and the place of the

Secret Extinguisher.

O P M I E. A pencil of rays diverging from any point of O to the Mirror, and thence converging to the like point of I, and proceeding to the eye.

P O R. The cone of visible objects.

A E B. The cone of aerial images.

CONCLUSION.

It would hardly accord with ancient usage to dismiss a scientific truth unenriched with a moral application; and luckily the following fragment of Cleanthes needs very little accommodation to suit our purpose:

> Κακουργότερον οὐδὲν Διαβολῆς ἔστι πω.
> Λάθρα γὰρ ἀπατήσασα τὸν πεπεισμένον,
> Μῖσος ἀναπλάττει πρὸς τὸν οὐδὲν αἴτιον.

Nought hath in mischief so perverse a skill
As Slander, that with sly small screen obstructs
An innocent light, and cheats the fool who trusts her.

APPENDIX.

NOTE A. *Page* 8.

Notices connected with the word IMAGINO.

Facciolati, following Calepin, as he follows the ancient Glossaries, explains *Imagino* by εικονιζω, a word as rare as itself, and equally unknown to the purer writers. Stephens cites only the authority of Aphthonius, an author, of whose age Fabricius knew no more than that it was "some years, or perhaps some ages later than the time of Hermogenes," who was a youth in the reign of Marcus Antoninus. But doubtless, both the words had been long current, and accounted emphatic, in provincial usage. The derivative εικονισμος, as we learn from a passage in Seneca (*Epist.* 95) compared with one in Trypho περι τροπων (*Mus. Crit.* vol. i. p. 55), was in use with the revenue officers, to signify 'a minute description of a man's person;' most probably like those in our Hue and Cry, and regimental description-books; their immense establishments (*Cic. pro lege Man.*) rendering such registers indispensable. By-the-by, as Seneca distinctly intimates that the use of εικονισμος, as a rhetorical term, was an innovation of his own, it is obvious that Trypho, who flourished in and before the reign of Augustus, was not the author of that tract. Of course, the same remark is applicable to the Scholiast on Odyss. T. 246, whom the pseudo Trypho follows: that Scholiast could not have been Didymus.

Imaginor, the deponent, or rather middle, form of *imagino*, is rendered, on the same authority, by φανταζομαι; which is quite erroneous, if the classical sense of the words is adhered to. I introduce them here, for the sake of showing the point of an unobserved witticism of Aristophanes. The genuine meaning of

φανταζομαι, as is well known, is "to appear in a fallacious or indistinct manner." But Euripides, from a principle of affectation for which he is ambiguously noticed in a well-known passage of Horace, and by Aristotle, (*Poetics*, ch. 22,) is fond of using it as a substitute for the ordinary φαινομαι, to appear or shew one's self. Aristophanes, in a play (in which Euripides is a prominent character), slily introduces it in the mouth of the most vulgar fellow of the piece, in place of φαινομαι, *to be had up* before the court. The comic poet nowhere else employs the word, and by its absence from Pindar and Sophocles also, it would appear to be little suited for poetic use.

The history of the words "Fancy" and "Imagination" would form no uninstructive chapter in the history of the human mind. Their different acceptation is a permanent memorial of the critical technicality connected with the copiousness of Greek loquacity, and the bold generalization to which the Roman gravity tended. An instance of this diversity of genius occurs, which is too remarkable and important to be passed by, however it exceeds the level of my subject. Let any scholar reflect how familiarly the Latin writers substitute the one word *imago* for words so different in their meaning as *effigies*, *simulacrum*, and *umbra*; and then observe how rigidly the Greek writers separate such words as εικων, χαρακτηρ, μορφη, απαυγασμα, from such as ειδωλον, σκια, φαντασμα, φαντασα; all of which are likewise included under *imago*; and unless his prejudices are strong indeed, he will be sensible, with what care the great Apostle has obviated all misconception respecting his views of the essential and (so to say) identical deity of the Saviour; and how signal is the providence which ordained that the Christian Scriptures should be conveyed in the most discriminating and least obscure of all languages.

NOTE B. *Page* 17.

"Though demonstrated, not true."—In his 27th and 28th propositions, the Greek writer proves that, when the line which joins the observer's eyes is bisected at right angles by the

axis of the mirror, and is not farther from the mirror than the length of the radius of the sphere, nor nearer than half that radius, neither of the eyes can be seen.—Whoever puts this to the proof, instead of seeing neither of his eyes, will be much puzzled to discern whether he sees three eyes or four, unless he look very steadily at the vertical diameter of the mirror; when he will soon find that he is looking at an eye very symmetrically formed and arched, and flanked by a couple of noses, with a regular pair of right and left eyes gleaming beyond them. But if he be subject either to headache or visions, he should not look too long at this trinocular apparition, as it requires a most fatiguing exercise of the eyes; which apparently are disconcerted that, although their axes are comfortably adjusted for an object at an easy distance, they are subjected to all the perplexity of an extroversive squint, with myopic indistinctness superadded.

These two propositions are, however, the most valuable in the Catoptrics, as they settle the limits of distinct and indistinct vision correctly, and contain the only intimation to be found in that treatise, of the situation of the geometrical focus of a concave mirror. Nor is it discreditable to have failed where none ever yet have been satisfactory. Dr. Smith, from a comparison of apparent magnitudes, places these images before the mirror. They may be so, though to demonstrate this is, I conceive, impossible; and, agreeably to another principle asserted by him, their indistinctness causes them to be referred to the most prominent or most familiar distinct object of attention, the surface of the mirror, or just beyond it.

Note C. *Page* 15.

By reversing the conditions of the 3d experiment, the trick of the Magic Beryl* or Crystal may be performed. A

* Aubrey (Miscellanies, p. 166) gives the description and history of a "Consecrated Berill," by means of which and a "Call" or form of prayer used with it, wonderful things were done, till it was "taken away by authority" about the year 1645.

ring like that used in this experiment being fixed vertically to a rising stand, must be placed over a table, so as to be opposite the vertical diameter of the mirror, and a little below its axis. A small magic lantern, furnished with slides, but without lenses, and having a sliding tin cap fitted upon the tube, so as to allow no light to pass, except through a small hole a little below the centre of the head of the cap, must be placed on a shelf just above the level of the mirror's axis.

The opening of the ring, and the hole in the lantern, being adjusted, as in experiment 3, to conjugate foci, the image of an object on the slide of the lantern will be seen through the ring only, but indistinctly, as being too near the eye. Let, therefore, a glass bulb filled with water, or a convex lens of short focus, be fixed in the opening of the ring; then, by a slight adjustment of the stand, the most convenient position will be obtained for viewing the image; which will appear to be formed within the bulb.

If a sentence is to be exhibited, it should be written on clear and moderately thin paper, and, being strained upon a slide, must be introduced inverted, and with the written side *towards the flame*. Paper slides are better than glass for showing painted figures also in this way.

Engrave the names of four angels on the ring, surmount it with a cross patee, hide the lantern and disguise the mirror with drapery and gloom, add mummery *quantum suff*, and the charm is complete.

The use of the broad margin of the ring in these performances is to hide the image or the shadow as they enter and leave the field of view.

THE END.

PRINTED BY GEORGE WOOD, PARSONAGE LANE, BATH.